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Patentanmeldung Nr. | Patent application No. | Demande de brevet n°

00401077.3

Der Präsident des Europäischen Patentamts;
Im Auftrag

For the President of the European Patent Office

Le Président de l'Office européen des brevets
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DEN HAAG, DEN
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LA HAYE, LE

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Sheet 2 of the certificate
Page 2 de l'attestation

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Bit rate allocation in joint bit rate transcoding

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Bit rate allocation in joint bit rate transcoding.

FIELD OF THE INVENTION

The present invention relates to a method of controlling a set of data compression channels. The data compression channels may be, for example, transcoding channels which process MPEG encoded data signals corresponding to different programs. The transcoded programs may be multiplexed so as to form a so-called bouquet. The bouquet may be transmitted to a receiver which selects and decodes a given program from the bouquet.

BACKGROUND OF THE INVENTION

The international patent application published under number WO 95/29559 describes a multiplexing system for controlling plural channel processors. The multiplexing system is described in Fig.1 and includes :

- a multiplexer (MUX) for providing a multiplexed signal (MS),
- plural channel processors (CP[1] to CP[n]), each channel processor (CP[i]) having a control input, a data input for receiving an input signal (IS[i]), a complexity output for providing a signal representing the complexity of an associated input signal, and a data output for providing an output data signal (OS[i]) to an associated input of the multiplexer,
- and a bit rate allocator (CONT) responsive to the complexity representing signals for providing bit rate control signals to the associated control inputs of the channel processors as a function of the complexity representing signals, such that a bit rate (Rout[i]) of an output data signal (OS[i]) from a channel processor (CP[i]) is a function of the complexity of an associated input data signal and to the combined of the input data signals.

In such a multiplexing system, the bit rate (Rout[i]) of an output data signal (OS[i]) from a channel processor (CP[i]) is equal to :

$$Rout[i] = \frac{X[i]}{\sum_{j=1}^{n} X[j]} Rtot$$

where
- i is the number of the channel processor,
- X[i] is the complexity of the preceding group of pictures (hereinafter referred to as GOP) period on a sliding window basis, that is the sum for all the pictures of that GOP of the product of the average quantisation

scale Qpic for a picture and the number of bits Tpic used to encode that picture : $X[i] = \sum_{GOP} Qpic \cdot Tpic$,

- Rtot is the total bit rate capacity available at the output of the multiplexer : $Rtot = \sum_{i=1}^{n} Rout[i]$.

SUMMARY OF THE INVENTION

It is an object of the invention to provide a method of controlling a set of transcoding channels that improves the bit rate allocation among the different transcoding channels and, as a consequence, that leads to a better repartition of the visual quality of the transcoded programs. The invention takes the following aspects into consideration.

The multiplexing system of the background art proposes a method of controlling a set of encoding channels. In this method, each encoding channel (CP[i]) receives the same proportion Rout[i] of the total bit rate capacity Rtot as the coding complexity X[i] of that encoder bears to the total coding complexity of all the encoding channels.

Such a distribution of the total bandwidth between all the programs corresponding to the different input signals (IS[1] to IS[n]) is not always sufficient and robust to take into account their complexity disparities, so that the bit rate allocation of complex programs is sometimes too much important compared to the ones of other programs. In these conditions, this bit rate allocation leads to the degradation of the visual quality of lower complexity programs.

The method of controlling a set of transcoding channels in accordance with the invention comprises :

- a step of computing an indicator of a compressed data quality for the respective transcoding channels, said indicator being computed from the input compressed data signal,
- a step of allocating the output bit rate to the transcoding channel from a total output bit rate, the corresponding indicator and a sum of the indicators of the transcoding channels.

Such a method of controlling a set of transcoding channels uses an indicator which has been determined for transcoding applications in order to ensure a better distribution of the total bit rate among the different transcoding channels. Moreover, the fact that the indicator is derived from the input compressed data signal makes its value independent from the regulation step performed by the transcoder. Thus, the method allows to avoid a drift in the bit rate allocation due to possible regulation mismatches.

The present invention also applies to a controller for controlling the bit rate allocation among a set of transcoders and to a multiplexing system comprising at least two transcoders and such a controller.

These and other aspects of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will now be described, by way of example, with reference to the accompanying drawings, wherein :

- Fig.1 is a block diagram corresponding to a multiplexing system in accordance with the background art,
- Fig.2 is a block diagram corresponding to a multiplexing system in accordance with the invention.

DETAILED DESCRIPTION OF THE INVENTION

The present invention relates to an improved method of controlling a set of transcoding channels. Such a method is described in the case of MPEG-2 compressed data signals but it would be apparent to a person skilled in the art that the scope of this invention is not limited to this specific case but can also be applied to any type of compressed data signals such as, for example, those provided by MPEG-4, H-261 or H-263 standards.

Fig.2 depicts a multiplexing system in accordance with the invention. Such a multiplexing system comprises a set of transcoders (TC[1] to TC[n]), a controller (CONT) and a multiplexer (MUX).

The set of transcoders comprises n transcoders where n is an integer at least equal to two. Each transcoder (TC[i]) allows to convert an input compressed data signal (ICS[i]) encoded at an input bit rate (Rin[i]) into an output compressed data signal (OCS[i]) encoded at an output bit rate (Rout[i]). Such a transcoder is intended to reduce the bit rate of the compressed data signals (Rout[i] < Rin[i]) in order to fulfil the transmission constraints required for broadcasting applications.

When at least two MPEG-2 transcoded programs are simultaneously transcoded, it is possible to jointly control the bit rate allocated to each transcoded program in such a way that a total bit rate (Rtot), which can be fixed or variable, is shared among the transcoded programs. This technique is called joint bit rate transcoding. With such a technique, the bit rate allocation is performed in order to obtain an overall picture quality that is equally distributed among the transcoded programs under the condition that each transcoder produces an MPEG-2 compliant output compressed data signal. For that purpose, the controller (CONT) receives from each transcoder parametric information on the regulation

process and the video coding complexity and subsequently computes the bit rate allocated (Rout[i]) to each transcoder (TC[i]). In the present invention, the controller receives also parametric information from the input compressed data signal (ICS[i]), this information being used to improve the bit rate allocation strategy.

Finally, the multiplexer (MUX) provides a multiplexed data signal (MS) at the total output bit rate (Rtot) from a multiplexing of the output compressed data signals (OCS[1] to OCS[n]).

The aim of joint bit rate transcoding is to equalise the picture quality over all the transcoded programs. To this end, a method of controlling a set of transcoding channels computes an indicator IND[i] of a compressed data quality corresponding to each transcoding channel (TC[i]). In the background art, the indicator is :

$$IND_{BA}[i] = X[i] \ ,$$

where - i is the number of the transcoding channel,

- X[i] is the complexity of the preceding GOP period, on a sliding window basis, calculated from the output compressed data signal (OCS[i]).

As it has been seen previously, this indicator does not give satisfactory results. According to the Test Model 5 of the MPEG-2 standard (available under reference ISO-IEC/JTC1/SC29/WG11), pictures with a high average macro-block complexity on luminance or chrominance, that is areas with many details, can be more degraded than others. Such an observation is taken into account in the present invention thanks to the introduction of a weighting factor wf[i] in the bit rate calculation. Moreover, in order to increase or decrease the quality of a program in comparison with the other programs, a nominal target bit rate value Rtar[i] is used for an optimal bit rate allocation. As a consequence, the indicator IND[i] corresponding to the preferred embodiment is calculated as follows :

$$IND[i] = \frac{X[i] \cdot Rtar[i]}{wf[i]} \ .$$

The optimum output bit rate (Rout[i]) allocated to a transcoding channel (TC[i]) is then computed as follows :

$$Rout[i] = \frac{IND[i]}{\sum_{j=1}^{n} IND[j]} \cdot Rtot \ .$$

As depicted in Fig.2, the weighting factor wf[i] is derived from the input compressed data signal (ICS[i]) without decoding it. The weighting factor can be seen as a retroaction in the method of controlling a set of transcoding channels and is used to complement the complexity value X[i], the latter value being calculated from the output compressed data

signal. The calculation of wf[i] is achieved at a picture level that can be a Predictive coded picture or an Intra coded picture.

In a first embodiment, the weighting factor wf1[i,t] is computed, for a current encoded picture numbered t, from an average over a set of Lmax encoded pictures, preceding the current picture in the encoding order, of a function of an average quantisation scale over a picture and a number of bits used to encode the same picture. Said weighting factor is equal to :

$$wf1[i,t] = \sum_{L=1}^{Lmax} (C1 + C2 \cdot Q(i,t-L) \cdot T(i,t-L))$$

where
- Lmax is a predefined integer (for example equal to 2M where M is the distance between a Predictive coded picture and the next Intra or Predictive coded picture) which allows to smooth temporally the calculation of wf1[i,t],
- Q(i,t-L) is the average quantisation scale for the picture numbered t-L,
- T(i,t-L) is the number of bits used to encode the picture numbered t-L, the products of the average quantisation scale Q(i,t-L) by the number of bits T(i,t-L) being homogeneous to a complexity X(i,t-L),
- C1 and C2 are integers used to smooth the sums of the complexity X(i,t-L). A coefficient C1 equal to 8 and a coefficient C2 equal to 1 ensure a good stability of the method.

In a second embodiment, the weighting factor wf2[i,t] is computed from a weighted average of a set of (Kmax+1) averages calculated over the set of Lmax encoded pictures and is equal to :

$$wf2[i,t] = \sum_{K=0}^{Kmax} \left[a_K \sum_{L=1}^{Lmax} (C1 + C2 \cdot Q(i,t-K-L) \cdot T(i,t-K-L)) \right]$$

where
- Kmax is a predefined integer (for example equal to M) which allows to smooth temporally the calculation of wf2[i,t],
- a_K is a set of weighting coefficients used to define a temporal weighting window applied to the averages calculated over the set of Lmax encoded pictures. The weighting coefficients a_K are for example { a0 = 0.6 ; a1 = 0.3 ; a2 = 0.1 } and are more important for pictures near the current picture than for distant pictures.

In this second embodiment, the first smoothing due to the average over the set of Lmax encoded pictures associated to the second smoothing due to the weighted average achieve a good stability and a good efficiency of the method of controlling a set of transcoding channels.

Thanks to the use of the weighting factor in the bit rate reallocation strategy, a better quality of the transcoded programs is obtained. Thus, no more sub-allocations of bit rate are performed on the less complex compressed data signals while the more complex ones are well transcoded. The disparities of complexity of the input MPEG-2 programs are taken into account, leading to a better distribution of the total bandwidth. Moreover, the additional calculation performed on each input compressed data signal is not only cost-effective, but also allows to use the input signal characteristics irrespective of the regulation strategy of each transcoding channel. As a consequence, such a method of controlling a set of transcoding channels avoids bit rate allocation drifts in some difficult transcoding conditions.

It will be obvious that the verb "comprise" does not exclude the presence of other steps or elements besides those listed in any claim.

CLAIMS

1. A method of controlling a set of transcoding channels (TC[1] to TC[n]), a transcoding channel (TC[i]) allowing to convert an input compressed data signal (ICS[i]) encoded at an input bit rate (Rin[i]) into an output compressed data signal (OCS[i]) encoded at an output bit rate (Rout[i]), said method of controlling comprising :
   - a step of computing an indicator of a compressed data quality for the respective transcoding channels, said indicator being computed from the input compressed data signal (ICS[i]),
   - a step of allocating the output bit rate (Rout[i]) to the transcoding channel (TC[i]) from a total output bit rate (Rtot), its corresponding indicator and a sum of the indicators of the transcoding channels.
2. A method of controlling a set of transcoding channels as claimed in claim 1, wherein the indicator is computed from an average over a set of encoded pictures of a function of an average quantisation scale over a picture and a number of bits used to encode the same picture.
3. A method of controlling a set of transcoding channels as claimed in claim 2, wherein the indicator is computed from a weighted average of a set of the averages calculated over the set of encoded pictures.
4. A controller (CONT) for controlling a set of transcoders (TC[1] to TC[n]), a transcoder (TC[i]) allowing to convert an input compressed data signal (ICS[i]) encoded at an input bit rate (Rin[i]) into an output compressed data signal (OCS[i]) encoded at an output bit rate (Rout[i]), said controller comprising :
   - means for computing an indicator of a compressed data quality for the respective transcoders, said indicator being computed from the input compressed data signal (ICS[i]),
   - means for allocating the output bit rate (Rout[i]) to the transcoder (TC[i]) from a total output bit rate (Rtot), its corresponding indicator and a sum of the indicators of the transcoders.
5. A data multiplexing system comprising :
   - a set of transcoders (TC[1] to TC[n]) for converting input compressed data signals (ICS[1] to ICS[n]) encoded at an input bit rate (Rin[1] to Ri[n]) into output compressed data signals (OCS[1] to OCS[n]) encoded at an output bit rate (Rout[1] to Rout[n]),
   - a controller (CONT) for controlling the set of transcoders and comprising :

- means for computing an indicator of a compressed data quality for the respective transcoders, said indicator being computed from the input compressed data signal (ICS[i]),
- means for allocating the output bit rate (Rout[i]) to the transcoder (TC[i]) from a total output bit rate (Rtot), its corresponding indicator and a sum of the indicators of the transcoders,

- a multiplexer (MUX) for providing a multiplexed data signal (MS) at the total output bit rate (Rtot) from a multiplexing of the output compressed data signals (OCS[1] to OCS[n]).

6. A computer program product for a controller (CONT) that comprises a set of instructions, which, when loaded into the controller causes the controller to carry out the method of controlling as claimed in claims 1 to 3.

Bit rate allocation in joint bit rate transcoding.

ABSTRACT

The present invention applies to a multiplexing system comprising a set of transcoders (TC[1] to TC[n]), a controller (CONT) and a multiplexer (MUX). The set of transcoders comprises n transcoders, each transcoder (TC[i]) allowing to convert an input compressed data signal (ICS[i]) encoded at an input bit rate (Rin[i]) into an output compressed data signal (OCS[i]) encoded at an output bit rate (Rout[i]). The controller (CONT) receives from each transcoder parametric information on the regulation process and the video coding complexity and subsequently computes the bit rate allocated (Rout[i]) to each transcoder (TC[i]) according to a total bit rate capacity available at the output of the multiplexer. The controller receives also parametric information from the input compressed data signal (ICS[i]), this information being used to improve the bit rate allocation strategy. Finally, the multiplexer (MUX) provides a multiplexed data signal (MS) from a multiplexing of the output compressed data signals (OCS[1] to OCS[n]).

Use: Multi-channel transcoding

Reference: Fig.2

1/2

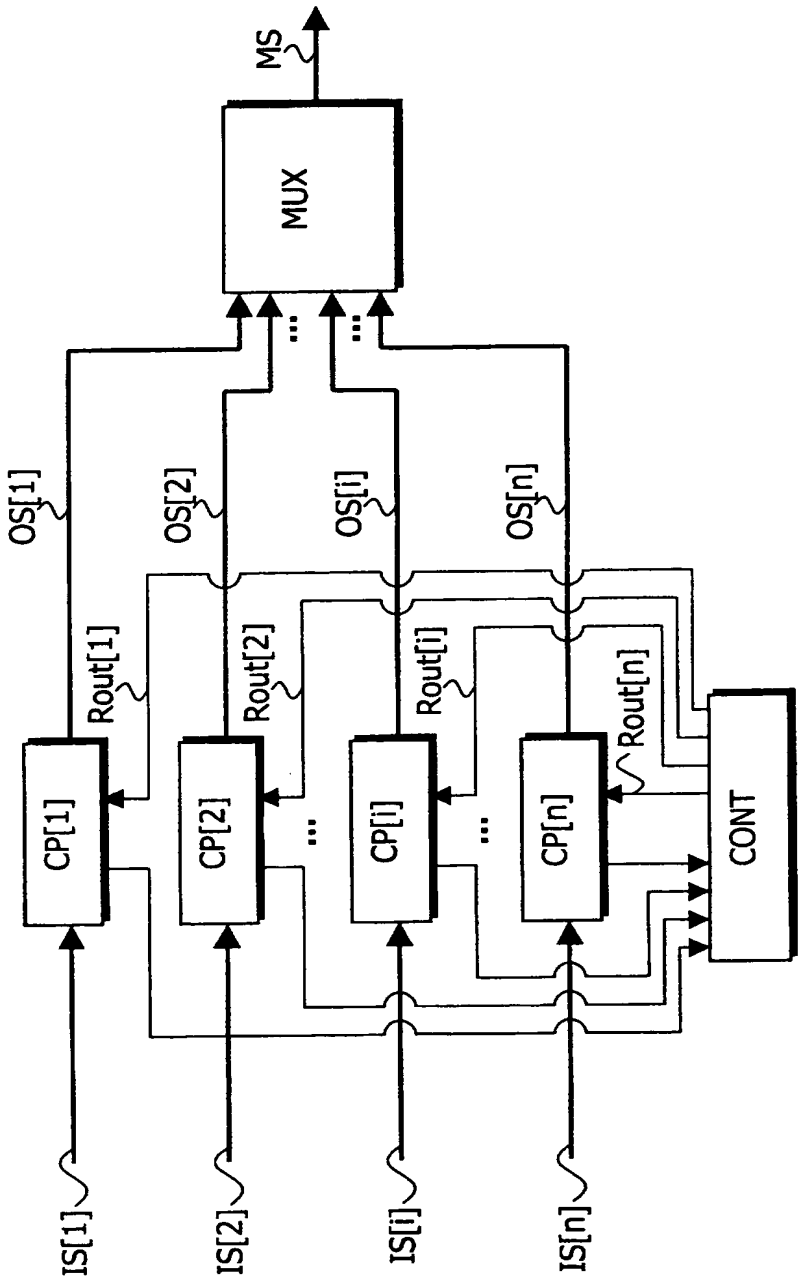
MS
MUX
OS[1]
OS[2]
OS[i]
OS[n]
Rout[1]
Rout[2]
Rout[i]
Rout[n]
CP[1]
CP[2]
CP[i]
CP[n]
CONT
IS[1]
IS[2]
IS[i]
IS[n]

FIG. 1

2/2

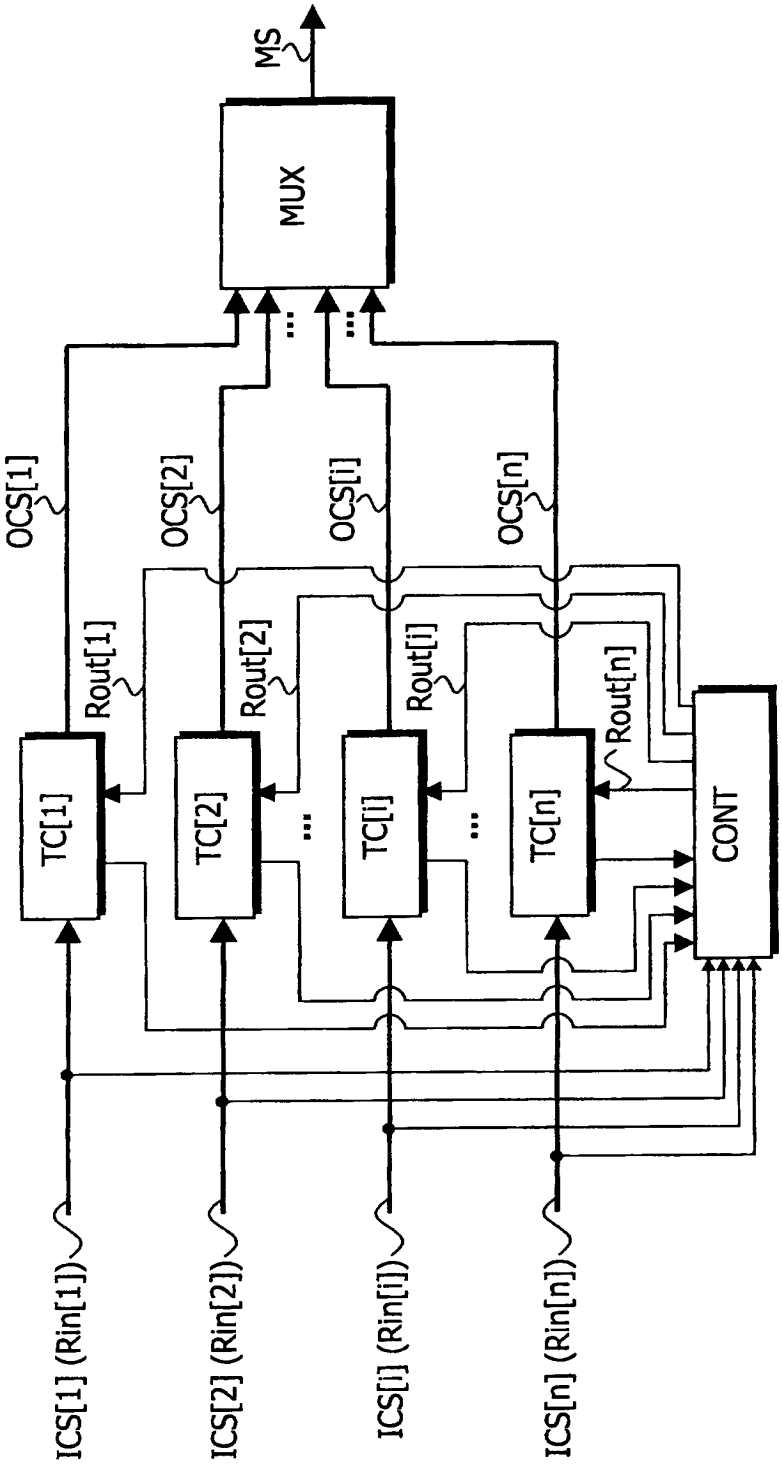
MS
MUX
OCS[1]
OCS[2]
OCS[i]
OCS[n]
Rout[1]
Rout[2]
Rout[i]
Rout[n]
TC[1]
TC[2]
TC[i]
TC[n]
CONT
ICS[1] (Rin[1])
ICS[2] (Rin[2])
ICS[i] (Rin[i])
ICS[n] (Rin[n])

FIG. 2